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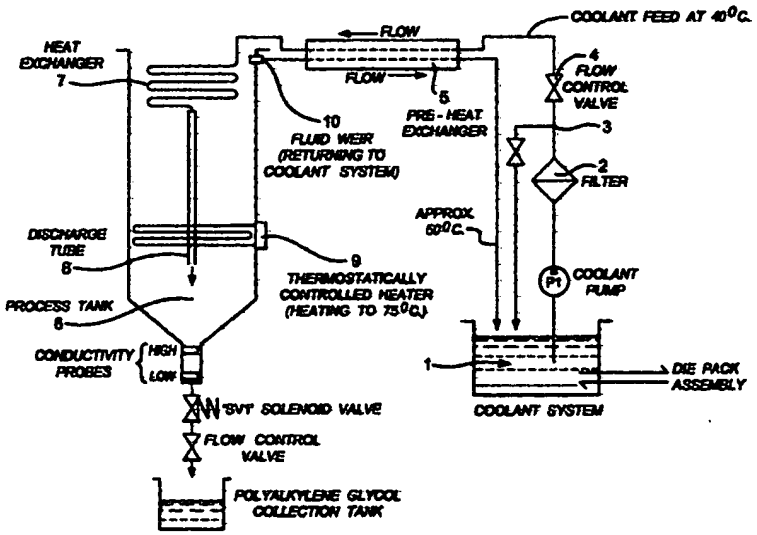
(54) Title: AN IMPROVED METALWORKING APPARATUS



(57) Abstract: A metalworking apparatus comprising a drive section and a die pack assembly. The drive section includes a reciprocally movable ram which is movable through forward working and rearward return strokes through the die pack assembly. The drive section is lubricated by a gear oil based on polyglycol, and the die pack assembly includes a water-based coolant. Seals are used to prevent cross-contamination of the gear oil and coolant. However, contamination does occur. The present invention therefore provides a removal apparatus for removing any polyglycol from the gear oil that has contaminated the coolant. The contaminated coolant is removed from and then returned to the die pack assembly on a continuous basis. The removal apparatus preferably includes a separation tank which separates the polyglycol from the coolant. The removal apparatus is preferably a portable system.

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An Improved Metalworking Apparatus

This invention concerns an improved metalworking apparatus, and, in particular, an improved apparatus for making metal cans.

Metal cans are currently prepared using, for example, the apparatuses disclosed in US-A-3,735,629 and US-A-4,173,138, which include a drive section and a die pack assembly, which are separated by one of more seals. The drive section includes a reciprocally movable ram which is movable through a relatively long forward working stroke and a rearward return stroke through multiple stages or ironing dies of the die pack assembly, in order to increase the axial or longitudinal length of a cup shaped metal part in order to produce a finished metallic can body. The drive section needs to be constantly lubricated with a gear oil in order to provide maximum movement accuracy and minimum wear. The die pack assembly produces a lot of heat and a coolant is required to absorb the heat. The coolant is usually water-based and needs to also provide some lubrication. The seals are used to prevent cross-contamination of the gear oil and coolant.

Although the seals are used to prevent cross-contamination of the gear oil and coolant, contamination does occur. The main problem in can manufacture is contamination of the coolant with the gear oil. If the coolant is contaminated with the gear oil, a sticky residue remains of the formed cans which needs to be removed using a high pressure water rinse. Unfortunately, the high pressure water rinse then becomes contaminated with the gear oil, so it needs to be replaced more quickly. Disposal of the contaminated water rinse is also a problem.

In order to reduce the problem of a sticky residue being left on the cans, the coolant is usually replaced after contamination with the gear oil reaches a certain level, such as, for example, around 5-10% of gear oil contaminates the coolant. Replacing the coolant due to contamination with the gear oil increases the cost of the process.

If the gear oil is contaminated with the coolant, which is water-based, corrosion can occur.

The aim of the present invention is to overcome the problem of cross-contamination of coolant and gear oil in a metal forming process, in particular in a can forming process.

WO 99/34942 proposes to overcome this problem by basing the gear oil and the coolant on the same lubricant. However, there is still a problem with contamination because the lubricant needs to be in a much higher concentration in the gear oil than in the coolant, and the coolant needs to be water-based.

In accordance with the present invention there is provided a metalworking apparatus comprising a drive section and a die pack assembly, the drive section including a reciprocally movable ram which is movable through forward working and rearward return strokes through the die pack assembly; the drive section being lubricated by a gear oil based on polyglycol; and the die pack assembly including a water-based

coolant; the apparatus further comprising a removal apparatus for removing any polyglycol from the gear oil that has contaminated the coolant.

The removal apparatus is preferably a portable system that is removable from the metalworking apparatus.

The removal apparatus preferably includes a separation tank which separates the polyglycol from the coolant. The separation tank preferably receives contaminated coolant from the metalworking apparatus on a continuous basis and then returns the cleaned coolant back to the die pack assembly at the same rate. The coolant may be removed and returned to the die pack assembly of the metalworking process at a rate of greater than 70 litres per minute, more preferably at a rate of greater than 100 litres per minute, and even more preferably at a rate of greater than 120 litres per minute.

The polyglycol that is removed from the contaminated coolant may be returned to the gear oil in the metalworking apparatus. The polyglycol is preferably reprocessed before it is returned to the gear oil. The polyglycol is preferably reprocessed to bring its anti-corrosion properties back up to the level of the gear oil in the metalworking apparatus before it is returned to the metalworking apparatus.

The coolant used in the die pack assembly is preferably continuously fed from a reservoir into the die pack assembly and then back into the reservoir. The reservoir may preferably feed more than one die pack assembly.

In a can forming process, the gear oil and the coolant are usually maintained at the same temperature, such as, for example, 40 °C, to prevent thermal contraction of the parts of the apparatus.

The gear oil and coolant preferably both include a water soluble polyalkylene glycol as the lubricant. The gear oil preferably includes more than 70% polyalkylene glycol, preferably more than 80% polyalkylene glycol, and even more preferably more than 90% polyalkylene glycol. The coolant preferably includes less than 5% polyalkylene glycol, more preferably less than 3% polyalkylene glycol, and even more preferably less than 1% polyalkylene glycol.

The gear oil and the coolant preferably also comprises an alkyl phosphate acid ester. The alkyl phosphate acid ester is preferably non-amine neutralised.

The polyalkylene glycol preferably has a molecular weight of less than 2,900, more preferably less than 2,000.

The non-amine neutralised, alkyl phosphate acid ester preferably comprises from 1 to 18, preferably from 5 to 10, more preferably 5 to 7, and most preferably 5 carbon atoms. The non-amine neutralised, alkyl phosphate acid ester preferably comprises a high proportion, preferably greater than 70%, of linear chains of carbon atoms. The non-amine neutralised, alkyl phosphate acid ester can also be:

(i) a mono-alkyl phosphate acid ester;

(ii) a di-alkyl phosphate acid ester;

(iii) a mixture of mono- and di-alkyl phosphate acid esters; and

(iv) a mixture of (i), (ii) and (iii) listed above.

The non-amine neutralised, alkyl phosphate acid ester can comprise free phosphoric acid and precursors.

The non-amine neutralised, alkyl phosphate acid ester is preferably a pentyl, hexyl, heptyl, octyl or nonyl phosphate acid ester or a mixture thereof. Preferably the alkyl phosphate acid ester predominantly contains pentyl or heptyl phosphate acid esters or a mixture thereof. By the term 'predominantly', we mean greater than 50%, preferably greater than 60%, more preferably greater than 70%, even more preferably greater than 80% and most preferably greater than 90%, by total weight of alkyl phosphate acid ester. The non-amine neutralised, alkyl phosphate acid ester can be a mixture of mono- and di-alkyl phosphate acid esters.

The non-amine neutralised, alkyl phosphate acid ester is available from, for example, Elf Atochem, Albright and Wilson and Bayer.

The polyalkylene glycol will usually have a viscosity at 40°C within the range of 20 to 10,000 centistokes and a viscosity at 100°C within the range of 3 to 2,000 centistokes.

The polyalkylene glycol may be based on the reaction product of a 1,2-oxide (vicinal epoxide) with water, alcohol or aliphatic polyhydric alcohol containing from 2 to 6 hydroxyl groups and from 2 to 8 carbon atoms per molecule. The polyalkylene

glycol may have an ethylene oxide (EO) to propylene oxide (PO) ratio of between 60-40% EO and 40-60% PO.

The polyalkylene glycol is available from Inspec ('BREOX') and Dow Chemicals ('SYNALOX').

The gear oil and coolant may also comprise the following usual additives: extreme pressure agents; anti-foaming additives; anti-wear additives; corrosion inhibitor additives; anti-oxidants; metal passivators; and vapour phase corrosion inhibitors.

Gear oils comprising water soluble polyalkylene glycols exhibit surface active properties. This presents the formulator of the gear oil with a challenge to provide the same level of corrosion inhibition, anti-wear and extreme pressure properties as obtained with mineral, ester and polyalphaolefin based lubricants.

The gear oil preferably comprises:

from 0.10 to 99.00%, more preferably 70 to 99%, of polyalkylene glycol;

from 0.01 to 5.00%, more preferably 0.10 to 1.00%, of phenolic antioxidant;

from 0.01 to 5.00%, more preferably 0.10 to 1.00%, of aminic antioxidant;

from 0.01 to 1.00% of benzotriazole;

from 0.005 to 1.00%, more preferably 0.005 to 0.5% of antifoam;

from 0.00 to 5.00%, more preferably 0.1 to 1.0%, of polysulphide;and

from 0.01 to 5.0%, more preferably 0.15 to 1.0%, of alkyl phosphate acid ester.

The gear oil exhibits compatibility with aqueous based metalworking fluids without affecting their function.

The gear oil should contain no mineral oil. However, the gear oil may contain insignificant amounts of mineral oil.

A preferred embodiment of the invention will now be described, by way of example only, with reference to the Figure which shows a schematic drawing of the removal process.

The removal apparatus is connected to a reservoir 1 that holds the coolant. (The coolant is continuously fed from the reservoir 1 to the die pack assembly (not shown) and then back to the reservoir.) The coolant is continuously removed from the reservoir 1 holding the coolant in the coolant system. The coolant is pumped through a filter 2 to remove metal fines and process contaminants from the coolant. The coolant may then be recycled back into the reservoir at point 3. Coolant that is not returned to the reservoir at 3 passes through a flow control valve 4 and through a pre-heat exchanger 5. In the pre-heat exchanger 5, the coolant is pre-heated to approximately 50 °C using hot coolant that is returning back to the reservoir 1. The coolant passes to a process tank 6 including a heat exchanger 7, a discharge tube 8, and a thermostatically controlled heater 9. In the process tank 6, the coolant is heated to above the cloud point of the polyalkylene glycol that has come from the gear oil. The cloud point for both Inspec's BREOX 50A140 and Dow's SYNALOX 50100B is 56 °C. In this example, the coolant is heated to 75 °C. The coolant passes from the heat exchanger 7, through the discharge tube 8 and into the bottom

of the process tank 6. This passage causes the polyalkylene glycol to be discharged to the bottom of the process tank as an insoluble product. The polyalkylene glycol may then be drained from the bottom of the process tank and reprocessed before it is returned to top up the gear oil. The cleaned coolant is then returned to the reservoir 1, through the fluid weir 10 and the pre-heat exchanger 5, in which the temperature of the heated coolant coming from the process tank 6 is used to pre-heat the coolant that is on its way to process tank 6. The coolant will be approximately 50 °C when it returns to the reservoir 1. This removal apparatus is used as a continuous process.

The cleaned coolant that is returned to the reservoir 4, through the weir 10, can also be redirected and used as the fluid to clean the cans before the dressing and lacquering stages. The fluid can be used in any part of the cleaning process, but preferably in the first rinsing stage. Any fluid used to clean the cans can be returned to the system, probably to the reservoir.

The apparatus described above enables the process fluids to be contained in the system, and minimises the opportunity for the glycol to be released into an effluent treatment stage, thus reducing effluent disposal levels and costs.

Claims

1. A metalworking apparatus comprising a drive section and a die pack assembly, the drive section including a reciprocally movable ram which is movable through forward working and rearward return strokes through the die pack assembly; the drive section being lubricated by a gear oil based on polyglycol, and the die pack assembly including a water-based coolant; the coolant and the gear oil being separated by at least one seal; the apparatus further comprising a removal means for removing any polyglycol from the gear oil that has contaminated the coolant.

2. The metalworking apparatus claimed in claim 1, wherein the removal means includes a separation tank which separates the polyglycol from the coolant.

3. The metalworking apparatus claimed in claim 2, wherein the separation tank is heated to above the cloud point of the polyglycol.

4. The metalworking apparatus claimed in claim 2, wherein the separation tank receives contaminated coolant from the metalworking apparatus on a continuous basis.

5. The metalworking apparatus claimed in claim 4, wherein coolant that has passed through the removal means to remove polyglycol is returned to the die pack assembly on a continuous basis at the same rate that it is removed therefrom.

6. The metalworking apparatus claimed in claims 4 or 5, wherein the coolant is removed from and returned to the die pack assembly of the metalworking process at a rate of greater than 70 litres per minute, more preferably at a rate of greater than 100 litres per minute, and even more preferably at a rate of greater than 120 litres per minute.

7. The apparatus claimed in any one of the preceding claims, wherein the polyglycol removed from the coolant is reprocessed and then returned to the gear oil in the metalworking apparatus.

8. The apparatus claimed in any one of the preceding claims, wherein the gear oil and the coolant both include a water soluble polyalkylene glycol as the lubricant

9. Use of the apparatus claimed in any one of the preceding claims, for the manufacture of metal cans from metal cups.

10. The removal apparatus defined in any one of the preceding claims, the removal apparatus being a portable system.

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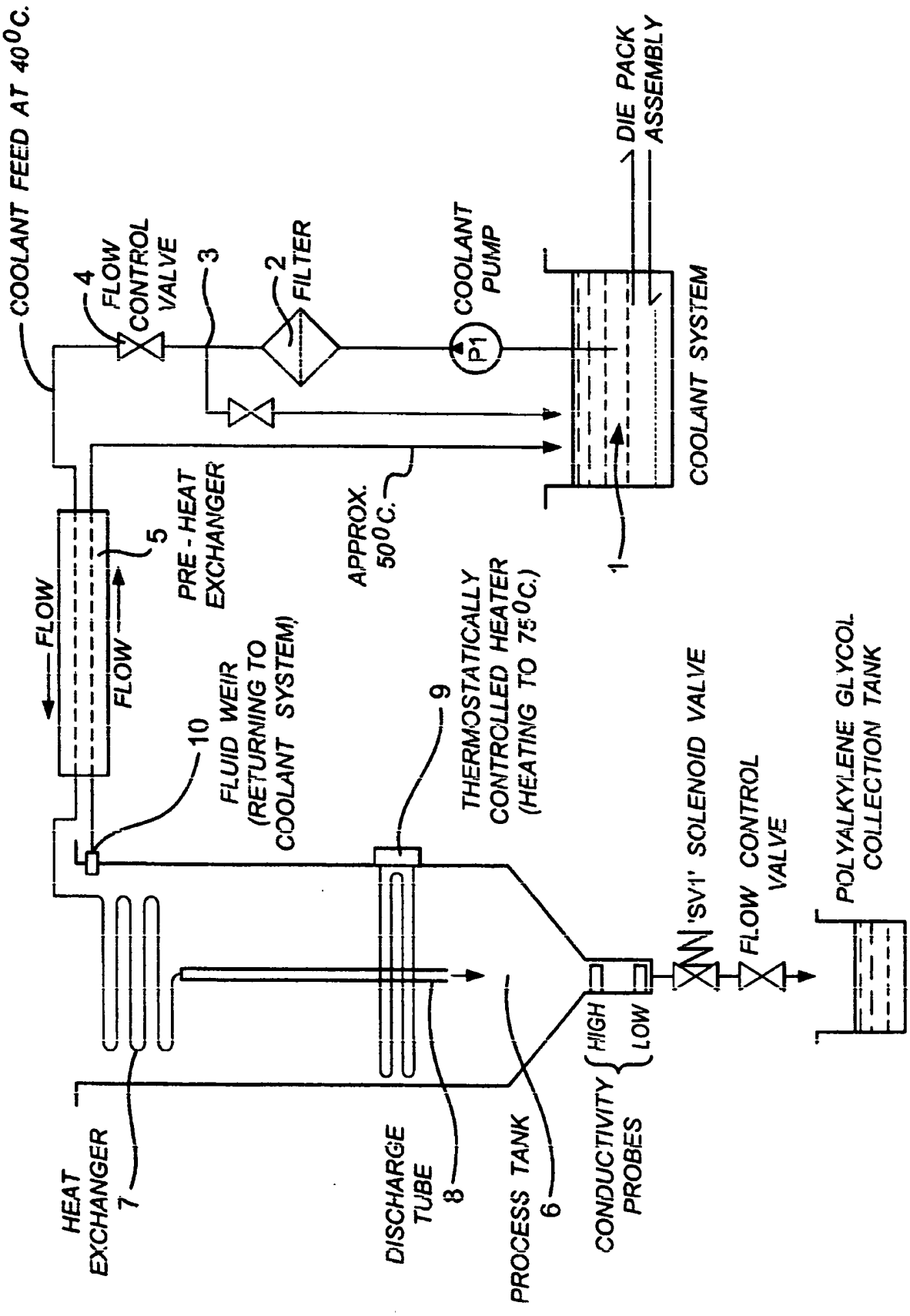
COOLANT FEED AT 40°C.
4 FLOW CONTROL VALVE
3
2 FILTER
COOLANT PUMP
P1
DIE PACK ASSEMBLY
COOLANT SYSTEM
1
APPROX. 50°C.
5 PRE - HEAT EXCHANGER
FLOW
FLOW
10 FLUID WEIR (RETURNING TO COOLANT SYSTEM)
9 THERMOSTATICALLY CONTROLLED HEATER (HEATING TO 75°C.)
'SV1' SOLENOID VALVE
FLOW CONTROL VALVE
POLYALKYLENE GLYCOL COLLECTION TANK
HEAT EXCHANGER 7
DISCHARGE TUBE 8
PROCESS TANK 6
CONDUCTIVITY PROBES
HIGH
LOW